

Applicant: Boyce et al.  
For: A Reinforced Joint for Composite Structures and  
Method of Joining Composite Parts

1. A method of joining composite parts comprising:  
disposing a plurality of reinforcing elements through the thickness of two  
adherends to be joined, at least a number of said reinforcing elements  
extending from the joint surface of each said adherend;  
assembling said adherends so that the joint surface of one said adherend  
is adjacent to the joint surface of the other said adherend defining a joint region therebetween,  
said reinforcing elements interstitially disposed in said joint region; and  
disposing an adherent within said joint region about said interstitially  
disposed reinforcing elements and said joint surfaces.

2. The method of claim 1 in which said adherends are carbon-carbon composite structures.

3. The method of claim 1 in which said reinforcing elements are fibers.

4. The method of claim 1 in which said adherent is a metallic braze material.

1                   5. A joined composite part structure comprising:

2                   a pair of composite adherends each including a plurality of reinforcing  
3                   elements disposed through the thickness thereof, at least a number of said reinforcing  
4                   elements extending from the joint surface of each said adherend;

5                   a joint region between said adherends bounded by the joint surface of each  
6                   said adherend and including said extending reinforcing elements interstitially disposed  
7                   therein; and

8                   an adherent about said extending interstitially disposed reinforcing  
9                   elements between said joint surfaces within the joint region.

1 6. A method of joining composite parts comprising:

2        *extrinsic* disposing a plurality of reinforcing elements *each extending* through the thickness of two  
3 composite adherends, said reinforcing elements extending from the joint surface of each  
4 said adherend;

5                assembling said adherends so that the joint surface of one said adherend  
6 faces the joint surface of the other said adherend;

7                disposing an adherent interlayer between said opposing joint surfaces;  
8                urging said extending reinforcing elements of each said adherend through  
9 said adherent interlayer and interstitially locking said reinforcing elements therein.

1 7. The method of claim 6 in which said adherent interlayer is a prepreg  
2 material, the method further including the step of curing said material. *Splines?*

1                   8. A joined composite part structure comprising:

2                   a pair of composite adherends, one said adherend including a plurality of

3                   reinforcing elements disposed through the thickness and extending from the joint surface

4                   thereof;

5                   a joint region between said adherends bounded by the joint surface of each

6                   said adherend and including the extending reinforcing elements of said one adherend

7                   disposed against the joint surface of the other said adherend; and

8                   an adherent disposed in said joint region about said extending reinforcing

9                   elements and between said joint surfaces.

1 9. A method of joining composite parts comprising:

c 2 disposing a plurality of reinforcing elements <sup>extrinsic</sup> <sub>each extending</sub> through the thickness of a  
3 first composite adherend to be joined, at least a number of said reinforcing elements  
4 extending from the joint surface of said first adherend;

5 assembling said first adherend with a second adherend such that the joint  
6 surface of the first said adherend faces the joint surface of the second said adherend at  
7 the joint region therebetween, said extending elements of said first adherend disposed  
8 against the joint surface of said second adherend; and

9 disposing an adherent within said joint region.

1 10. A method of joining composite parts comprising:

c 2 disposing a plurality of reinforcing elements <sup>extrinsic</sup> <sub>each</sub> extending through the thickness of a  
3 first composite adherend at the joint surface of said first adherend, at least a number of  
4 said reinforcing elements extending from the joint surface of said first adherend;  
5 assembling said first adherend with a second adherend such that the joint  
6 surface of the first said adherend faces the joint surface of the second said adherend;  
7 disposing an adherent interlayer between said opposing joint surfaces; and  
8 urging said extending reinforcing elements of said first adherend through  
9 said adherent interlayer and against the joint surface of the second said adherend and  
10 locking said reinforcing elements therein.

1 11. The method of claim 10 in which said adherent interlayer is a prepreg

2 material, the method further including the step of curing said prepreg.

1 12. A method of joining composite parts comprising:

C 2 disposing a plurality of reinforcing elements <sup>extensive</sup> <sub>each</sub> extending through the thickness of two

3 composite adherends at the joint surface of each said adherend to be joined;

4 assembling said adherends so that the joint surfaces of one said adherend

5 faces the joint surface of the opposing said adherend;

6 disposing an adherent within the joint region defined by said facing joint

7 surfaces and urging said adherent to flow at least partially along the length of said

8 reinforcing elements within said adherends.

1                   13. A method of joining a composite part with a non-composite part  
2                   comprising:  
3                   inserting, through the thickness of said composite part, a plurality of  
4                   reinforcing elements extending from the joint surface thereof;  
5                   assembling said composite part such that said reinforcing elements are  
6                   proximate the joint surface of said non-composite part; and  
7                   brazing said joint surfaces and said reinforcing elements to form a joint.



1                   15. A method of joining composite parts comprising:

2                   inserting, through the thickness of one said composite part, a plurality of  
3                   *extrinsic* reinforcing elements extending from the joint surface thereof;

4                   assembling one said composite part with a second composite part such that  
5                   said reinforcing elements are disposed about the joint surface of said second composite  
6                   part;

7                   selecting a braze material compatible with said composite parts, and said  
8                   reinforcing elements;

9                   applying said braze material to the joint region between said composite  
10                  parts;

11                  urging said braze material to flow about said reinforcing elements; and  
12                  allowing said braze material to harden.

1                   16. A method of joining composite parts comprising:  
2                   inserting, through the thickness of each said composite part, a plurality  
3                   of *extrinsic* reinforcing elements extending from the joint surface thereof;  
4                   selecting an adherent interlayer material for joining said parts;  
5                   assembling said composite parts such that said joint surfaces face each  
6                   other with said adherent interlayer therebetween;  
7                   driving said reinforcing elements into said adherent interlayer and curing  
8                   said adherent interlayer locking said reinforcing elements therein.

1                   17. A method of claim 16 in which said adherent interlayer is a prepreg  
2                   material and the step of driving said reinforcing elements and curing includes subjecting  
3                   the assembly to elevated pressure and temperature.

18. A method of joining composite parts comprising:

inserting, through the thickness of one composite part, a plurality of

### extrinsic reinforcing ele

reinforcing elements extending from the joint surface thereof;

selecting an adherent interlayer material for joining said parts;

assembling said composite parts such that said joint surfaces face each

other with said adherent interlayer therebetween;

driving said reinforcing elements into said adherent interlayer and curing

said adherent interlayer locking said reinforcing elements therein.

1                   19. A method of joining a composite part with a non-composite part  
2                   comprising:  
3                   inserting, through the thickness of said composite part, a plurality of  
4                   reinforcing elements at least at the joint region thereof;  
5                   assembling said composite part such that said reinforcing elements are  
6                   disposed proximate the joint surface of said non-composite part; and  
7                   brazing said joint surfaces and urging braze material to flow along the  
8                   lengths of said reinforcing elements into said composite part.

1 20. A method of joining composite parts comprising:

2 disposing a plurality of reinforcing elements through the thickness of the  
3 composite adherends to be joined, at least a number of said reinforcing elements exposed  
4 at the joint surface of each said adherent;

5 assembling said adherends so that the joint surface of one said adherend  
6 faces the joint surface of the other said adherend defining a joint region therebetween;  
7 and

8 disposing an adherent within said joint region and about said exposed  
9 reinforcing elements and said joint surface.

1                   21. A joined composite part structure comprising:

2                   a pair of composite adherends each including a plurality of reinforcing  
3                   elements disposed through the thickness thereof, at least a number of said reinforcing  
4                   elements exposed at the joint surface of each said adherend;  
5                   a joint region between said adherends bounded by the joint surface of each  
6                   said adherend and including said exposed reinforcing elements; and  
7                   an adherent about said exposed reinforcing elements between said joint  
8                   surfaces within the joint region.

1 22. A method of joining a composite part with a non-composite part,

2 comprising:

3 inserting, through the thickness of said composite part, a plurality of

c 4 *extrinsic* <sup>1</sup> reinforcing elements at least at the joint region thereof, said reinforcing elements exposed

5 at the joint surface of said composite part;

6 assembling said composite part such that said exposed reinforcing

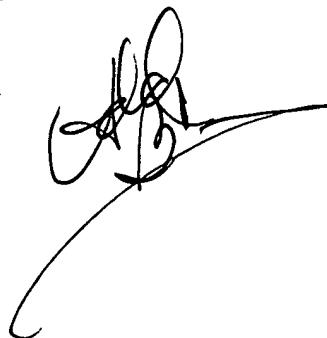
7 elements are disposed proximate the joint surface of said non-composite part; and

8 disposing an adherent about said exposed reinforcing elements and said

9 joint surfaces.

1           23. A joined structure comprising:

2           a first adherend having a plurality of reinforcing elements disposed  
3           through the thickness thereof exposed at least at the joint surface thereof;  
4           a second adherend the joint surface of which is proximate said exposed  
5           reinforcing elements of the first adherent;  
6           a joint region between said adherends bounded by the joint surface of each  
7           adherend including said exposed reinforcing elements of said first adherend; and  
8           an adherent disposed in said joint region about said exposed reinforcing  
9           elements and between said joint surfaces.

A handwritten signature in black ink, appearing to read "John Doe". It is written in a cursive style with a long, sweeping line extending from the left.